PROC. ENTOMOL. SOC. WASH.
94(1), 1992, pp. 26–47

SEVEN NEW NORTH AMERICAN SPECIES OF *NEONEURUS* (HYMENOPTERA: BRACONIDAE)

Scott Richard Shaw

Department of Plant, Soil, and Insect Sciences, University of Wyoming, P.O. Box 3354, Laramie, Wyoming 82071.

Abstract.—Pertinent literature on the holarctic genus *Neoneurus* Haliday is reviewed and summarized. Seven new North American species are described and illustrated: ***Neoneurus diabolicus, Neoneurus mantichora, Neoneurus mantis, Neoneurus masneri, Neoneurus pallidus, Neoneurus portalensis***, and ***Neoneurus spinarius***. These are the first *Neoneurus* species to be named from the Nearctic region. The genus *Neoneurus* is diagnosed, and a key to known world species is provided. Some observations on the behavior of *Neoneurus mantis*, an ant-associated species from Wyoming, are given.

Key Words: Parasitoid, ant-associated, holarctic, new species

Parasitoid species of the ant-associated holarctic genus *Neoneurus* Haliday may justifiably be considered among the rarest and most remarkable of the braconid wasps occuring in North America. Neoneurine species are thought to be koinobiont endoparasitoids of adult worker ants; however, information on their biology and behavior is very sparse. Although they are most usually found in association with ants, and oviposition has been observed, the details of larval development are not known. Most *Neoneurus* females are distinctive in having greatly modified fore legs (Figs. 3–24), which presumably are used to brace their position during oviposition. Several species have been named from the Palearctic region, and although their existence in the Nearctic region has been known for many years (Marsh 1979) and was suspected for quite some time before that (Muesebeck 1922), none of the North American species has yet been named or described. Their relative rarity is demonstrated by the fact that the largest North American collection of Braconidae, that of the U.S. National Museum of Natural History (USNM), has only accumulated a total of eleven *Neoneurus* specimens (of which only two are females). Consequently, the discovery during the summers of 1990 and 1991 in Wyoming of a reliably locatable population of *Neoneurus* and the collection of thirty-six specimens is a matter of general scientific interest. The initial purpose of this paper was to describe and name this new *Neoneurus* species, as a necessary precursor to publishing observations on its biology and behavior. As the work progressed, additional specimens of other *Neoneurus* species were discovered in several museums, consequently this study has matured into a complete synopsis of the *Neoneurus* species in the Nearctic region and a review of the Palearctic species. In view of the obscure nature of *Neoneurus* species, it seems very likely that additional species will be discovered in the near future. This work does, however, provide a complete summary of the *Neoneurus* species known at present and their distributions. It is hoped that this work will stimulate further discoveries of *Neoneurus* and inspire additional studies on the

behavior of these magnificent ant-associated parasitoids.

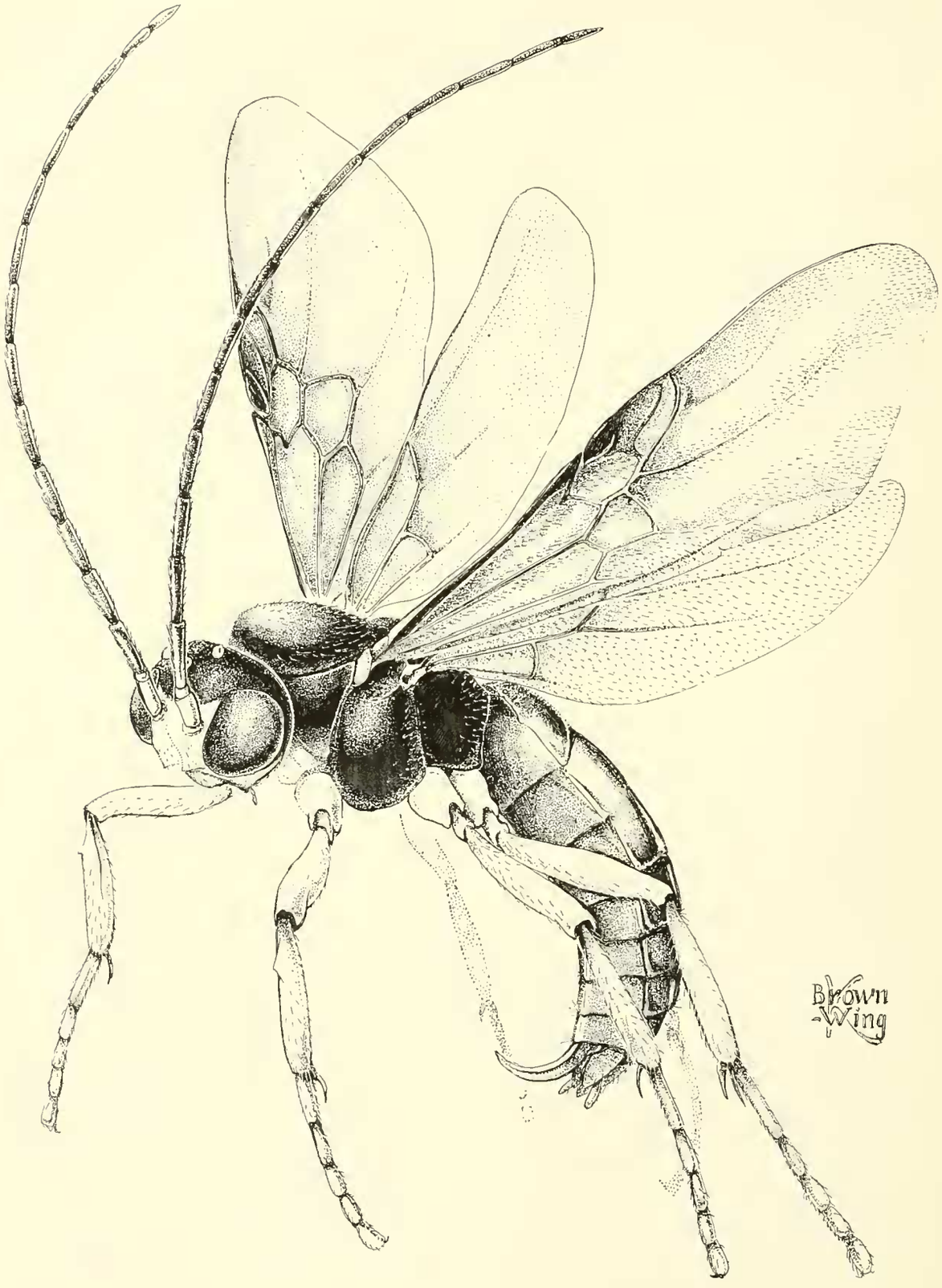
Genus *Neoneurus* Haliday
(Figs. 1–30)

Neoneurus Haliday, 1838. No species included. Type species: *Neoneurus halidaii* Marshall (by subsequent monotypy). First included species by Marshall, 1897.

Ecclites Foerster, 1862. Type species: *Ecclites clypeatus* Foerster (original designation). Synonymized with *Neoneurus* by Ashmead, 1900.

Diagnosis of female.—Body small, 2–4 mm long; lower parts of head, especially face, and legs pale colored; mesosomal and metasomal color varying from black to reddish or yellowish brown; head large, transverse, broader than mesonotum; face often with a pair of spinose protuberances; clypeus short and wide, lower margin truncate; labrum flexible and often exposed; mandible narrow, curved, and bidentate; maxillary palpi 2-segmented; labial palpi 1-segmented; compound eye large, but only slightly prominent, smooth, antero-ventrally converging; ventral facets of compound eye larger than dorsal facets; malar space narrow, distinctly less than basal width of mandible; occiput convex; occipital carina absent; antenna filiform and sparsely setose, slightly longer than fore wing, distinctly longer than the head and mesosoma together; flagellum with 14 flagellomeres; mesonotum broad, convex, abruptly declivous anteriorly; notauli absent; scutellum separated from mesonotum by a smooth transverse sulcus; fore wing with a short, complete radial cell, with a spectral spurious vein (wing fold) extending from apex of radial cell towards wing margin; costa and metacarpus abnormally thick; pterostigma broad, with a pouch-like fold at anterior edge, visible from below; second cubital cell small, subquadrate, weakly indicated by spectral intercubiti; recurrent vein spectral, five-sided discoidal cell open apically; apex of fore wing without an apparent apical fringe of setae (at 80×); prosterna enlarged, subquadrate; legs slender; femorae, especially fore femora, compressed; fore tibia robust, often with a basal longitudinal carina along inner margin and a subbasal protuberance on anterior margin; tibial spurs large and distinct, larger spur at least ½ as long as basitarsus; tarsi slender, tapering towards apex; tarsal claws minute; pulvilli, especially fore pulvillus, greatly enlarged (Figs. 13–14); hind trochantellus obsolescent; anterior subalar depression with a distinct tubercle; first metasomal tergum longer than broad, contracted behind the spiracles, and sessile basally; terga 2 and 3 flat dorsally, sharply folded laterally; metasoma narrow, with apex strongly compressed; ovipositor shorter than hind basitarsus, compressed, sickle-like, and strongly curving anterad when exserted; ovipositor emerging subapically when exserted, withdrawn into metasoma when at rest (most specimens die with the ovipositor exserted).

Male.—Moderately sexually dimorphic: body smaller than in female; head, mesosoma, metasoma, and coxae mostly black; head not as wide as in female, about as broad as mesonotum; face evenly convex, without a pair of spinose protuberances; clypeus short and wide; labrum less conspicuously exposed; compound eye smaller than in female, slightly less prominent, and not so strongly converging antero-ventrally; ventral facets of compound eye not discernibly larger than dorsal facets; malar space slightly wider than in female; flagellum densely setose and slightly shorter than in females, about as long as fore wing; fore tibia normal, more slender than in female, without a basal longitudinal carina along inner margin or a subbasal protuberance on anterior margin; tibial spurs shorter than in female; tarsi more slender and longer than in female; pulvilli not so greatly enlarged; metasoma shorter, not so narrow or strongly compressed as in female; cuspides not dissociated; cuspidal lobes broad, with six regularly arranged sen-



1. Habitus of *Neoneurus mantis* female, antero-lateral view.

sillae; digitus with abundant spinules (male genitalia of *Neoneurus viennense* Giraud illustrated by Tobias 1966); otherwise as in female.

Remarks.—Although rarely encountered, their aberrant wing venation (Figs. 1, 2) allows both male and female neoneurines to be easily diagnosed to subfamily and genus. Specimens may be identified to subfamily using the illustrated key to the subfamilies of holarctic Braconidae (van Achterberg 1990). Specimens may be identified to ge-

nus using the keys of Muesebeck (1922), Huddleston (1976), or Marsh et al. (1987). The remarkable fore legs of *Neoneurus* females (Figs. 3–24) are unique within the family Braconidae.

The only genera of the subfamily Neoneurinae known to occur in North America are *Neoneurus* and *Elasmosoma*. Species of *Elasmosoma* were revised by Huddleston (1976). Two additional genera, *Euneoneurus* and *Parelasmosoma*, were recently described to include certain remarkable Asian species (Tobias and Yuldashev 1979). Keys to neoneurine genera and *Neoneurus* species occurring in the western part of the USSR were provided by Tobias et al. (1986).

Taxonomic characters of value at the species level.—Sexual dimorphism is more extreme than in most braconids, and the differences between species are most obvious when comparing female specimens. Most apparent are the unusual modifications of the female fore leg (Figs. 3–16, 19–24), and the development of facial spinules or spines (Figs. 27–28). The modified female fore leg is formed by the compression of the fore femur (e.g. Fig. 21), shortening of the fore tibia (e.g. Fig. 6) and development of a tibial carina and an associated sharp tubercle (e.g. Fig. 5), enlargement of the tibial spur (e.g. Fig. 14), shortening of the fore tarsus (e.g. Fig. 10), and enlargement of the fore pulvillus (e.g. Fig. 13). Presumably these adaptations are raptorial in nature, allowing the female to grasp the rapidly moving host ant securely, although briefly, during oviposition. However, limited observations indicate that oviposition is extremely rapid, and an hypothesis of raptorial function for the female fore leg cannot be confirmed or rejected at the present time. Likewise, the facial spines (e.g. Fig. 28) may be developed to allow the female to better position herself on the rapidly moving host ant, by bracing the head against the posterior margin of metasomal tergum 2. However, high-speed photography of the oviposition sequence will be needed to examine these hypotheses.

Body color is moderately variable, especially between females of different species. Size of the ovipositor is not a very useful taxonomic character in *Neoneurus* species since the ovipositor is retracted into the metasoma when not in use, therefore its apparent size is actually an artifact of its position at the death of a particular specimen. Likewise, the body length of dead specimens is apparently more variable than it actually would be in live specimens, since in some dead specimens the metasoma is bent forwards or shriveled. Fore wing length is a better indicator of relative body size. Diagnosis of males is difficult. Unfortunately, some of the species described so far in the Palearctic region were based on male type specimens.

Hosts.—Associated with adult worker ants, particularly those of the *Formica fusca* and *rufa* species-groups (Shenefelt 1969). Donisthorpe (1927) reports observing *Elasmosoma* ovipositing in the metasoma of adult worker ants, and also claims to have reared them from observation nests. As clarified by Huddleston (1976), Donisthorpe's observations probably pertain to *Neoneurus*, following Morley's (1914b) misidentification of *Neoneurus halidaii* Marshall as *Elasmosoma berolinense* Ruthe, a nomenclatorial confusion that persisted until cleared up by Nixon (1934), although noted by Muesebeck (1922).

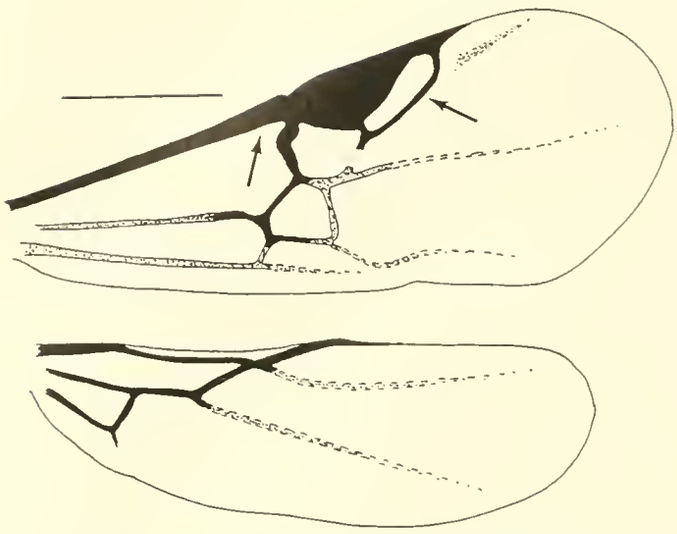
*Key to the Known Species of *Neoneurus*

1 Females: apical flagellomere narrow and only moderately setose (as in Fig. 25) .. 2
[*female unknown for *clypeatus*]

– Males: apical flagellomere ovate and densely setose (as in Fig. 26) 12
[*male unknown for *curvicalcar*, *manti-chorus*, and *spinarius*]

2(1) Anterior longitudinal carina of fore tibia produced into two thorn-like projecting spines, one medially and one basally (as in Figs. 7–8) 3

– Anterior longitudinal carina of fore tibia not produced into two thorn-like projecting spines, although one blunt projection



2. Wings of *Neoneurus diabolicus* female.

is often present basally, no such spine is present medially (as in Fig. 5) 5

3(2) Nearctic species 4

– Palearctic species (Mongolia) ..... *Neoneurus armatus* Tobias

4(3) Facial spines shorter than antennal scape; head with occiput pale yellowish white; United States (Arizona) ..... *Neoneurus portalensis*, new species

– Facial spines longer than antennal scape; head with occiput black; United States (California) ..... *Neoneurus spinarius*, new species

5(2) Fore tibial spur large and sometimes strongly curved (e.g. Figs. 14 and 16), as long or longer than ½ tibia length (as in Figs. 20, 22 and 24); facial spines long and distinct (as in Fig. 28), about as long, or longer than, antennal pedicel 6

– Fore tibial spur relatively smaller and only slightly curved (as in Figs. 9–10), distinctly shorter than ½ tibia length; facial spinules much smaller and less distinct (as in Figs. 1 and 27) or absent, always shorter than antennal pedicel 10

6(5) Fore tibial spur shorter than fore basitarsus (as in Fig. 16) *and* facial spines shorter than antennal scape; Palearctic species .. 7

– Fore tibial spur as long as fore basitarsus (as in Fig. 14) *or* facial spines longer than antennal scape (as in Fig. 28); North American species 8

7(6) Subbasal tibial protuberance falcate; facial spines separated by distance distinctly greater than scape width; Austria, Czechoslovakia, Denmark, Finland, Netherlands, Sweden, Yugoslavia ..... *Neoneurus viennense* Giraud

– Subbasal tibial protuberance not falcate; facial spines separated by distance equal to scape width; Kazakhstan ..... *Neoneurus curvicalcar* Belokobylskij

8(6) Facial spines as long as antennal scape .. 9

– Facial spines shorter than antennal scape; United States (Georgia) ..... *Neoneurus mantichorus*, new species

9(8) Fore tibial spur sharply curved apically (Fig. 14); facial spines widely spaced (Fig. 28), the distance between their tips distinctly greater than width of median ocellus; United States (North Dakota) ..... *Neoneurus diabolicus*, new species

– Fore tibial spur relatively straighter (Fig. 12), only gradually curved apically; facial spines close together, the distance between their tips about equal to width of median ocellus; United States (Oregon, Washington) ..... *Neoneurus masneri*, new species

10(5) Facial spinules present, although small (as in Figs. 1 and 27); fore basitarsus distinctly shorter than fore tibia (as in Figs. 19–20); fore tibia with a distinct basal longitudinal carina along inner margin and a subbasal protuberance on anterior margin (as in Figs. 3–5); North American species 11

– Facial spinules absent; fore basitarsus about equal in length to fore tibia; fore tibia without a distinct basal longitudinal carina along inner margin or a subbasal protuberance on anterior margin; European species ..... *Neoneurus auctus* (Thomson)

11(10) Mesosoma extensively marked with yellowish brown, especially mesonotum anteriorly, pronotum laterally, and mesopleuron ventrally (Fig. 29); Canada (Ottawa) and United States (Colorado, North Carolina, Michigan, Virginia) .... *Neoneurus pallidus*, new species

– Mesosoma mostly black (Fig. 1); Canada (Alberta, British Columbia) and United States (California, Oregon, Wyoming) .. *Neoneurus mantis*, new species

12(1) Nearctic species 13

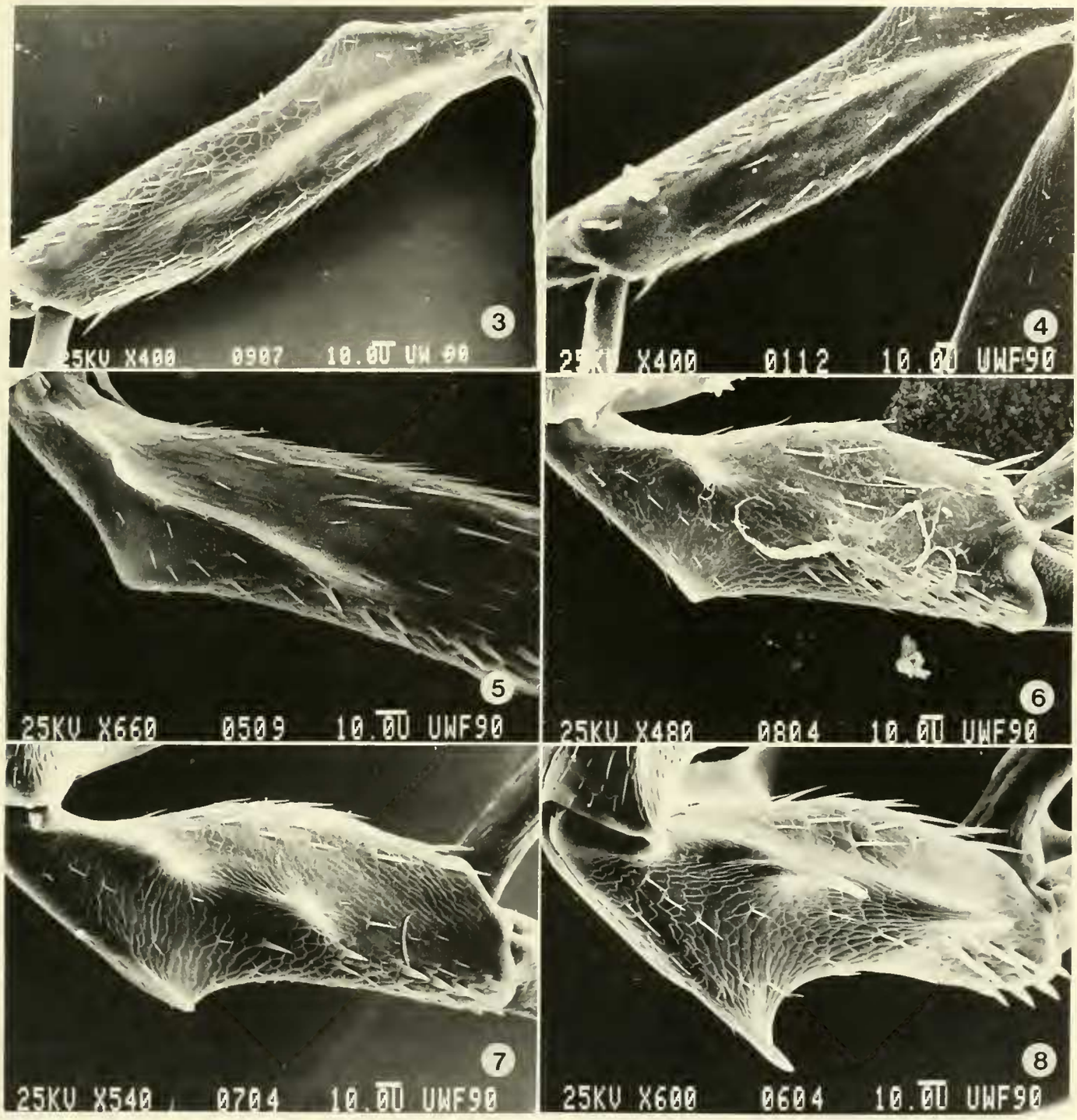
– Palearctic species 17

13(12) Tegula pale yellow or whitish; hind coxa mostly yellowish brown or, at most, infused with brown basally 14

– Tegula dark brown; hind coxa mostly black 16

14(13) Face, scape, and sometimes pedicel marked with pale yellowish brown (Fig. 30); prosternum yellowish brown; fore tibial spur evenly curved and about ½ as long as basitarsus; Canada (Ottawa) and United States (Colorado, North Carolina, Michigan, Virginia) ... *Neoneurus pallidus*, new species

– Face black or black irregularly infused with



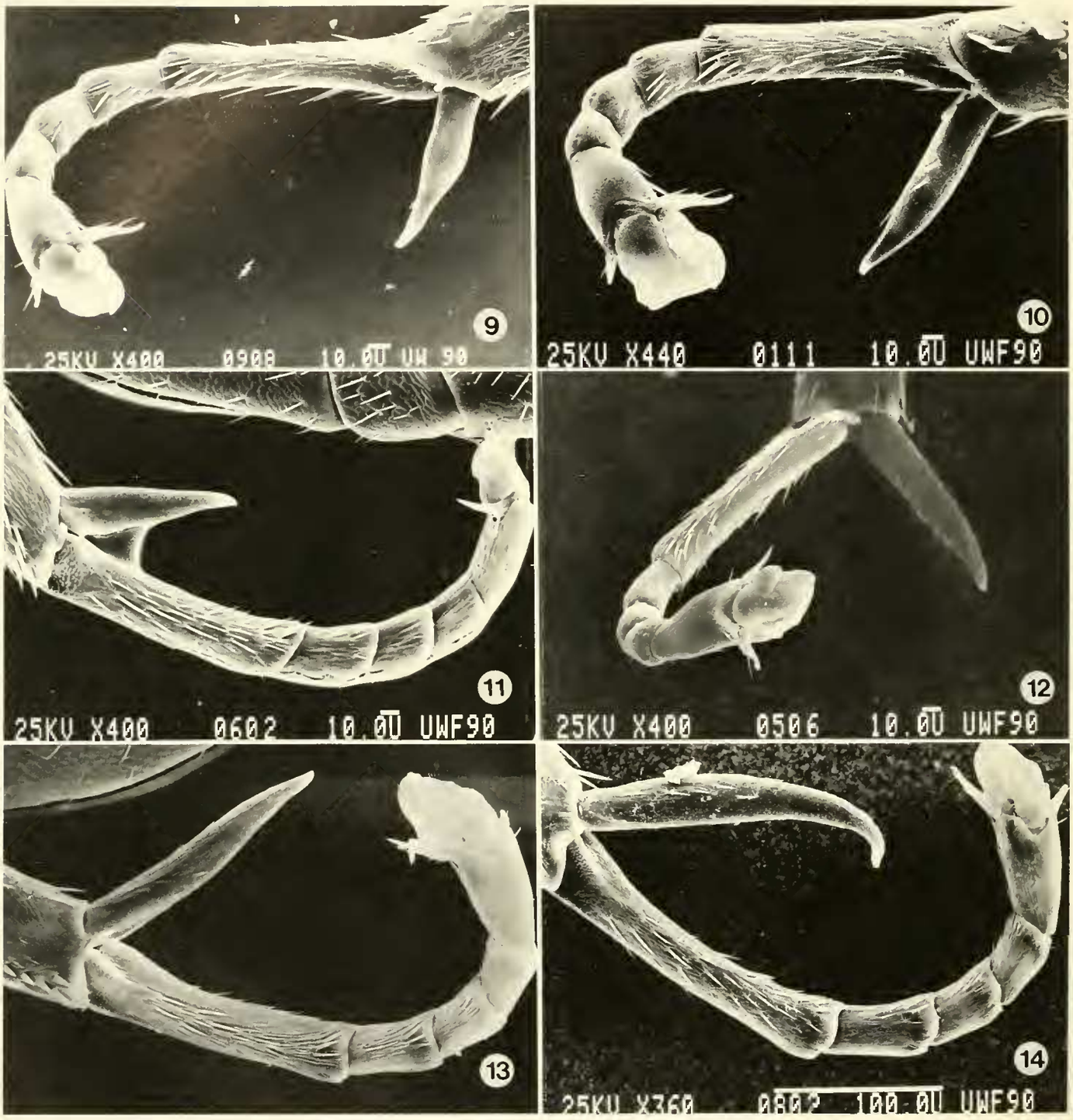
3. Fore tibia of *Neoneurus mantis* female.
4. Fore tibia of *Neoneurus pallidus* female.
5. Fore tibia of *Neoneurus masneri* female.
6. Fore tibia of *Neoneurus diabolicus* female.
7. Fore tibia of *Neoneurus portalensis* female.
8. Fore tibia of *Neoneurus spinarius* female.

yellowish brown, scape and pedicel brown; prosternum dark brown or black; fore tibial spur curved in basal ¼ then relatively straight, definitely more than ½ as long as basitarsus 15

15(14) Clypeus entirely pale yellowish white; fore tibial spur nearly as long as basitarsus (Fig. 18); United States (Arizona) .... *Neoneurus portalensis,* new species

– Clypeus yellowish brown, darker dorsally; fore tibial spur about ¾ as long as basitarsus; United States (North Dakota) ... . *Neoneurus diabolicus,* new species

16(13) Wings distinctly infumate; nonmarginal



9. Fore tibial spur and tarsus of *Neoneurus mantis* female.
10. Fore tibial spur and tarsus of *Neoneurus pallidus* female.
11. Fore tibial spur and tarsus of *Neoneurus spinarius* female.
12. Fore tibial spur and tarsus of *Neoneurus masneri* female.
13. Fore tibial spur and tarsus of *Neoneurus portalensis* female.
14. Fore tibial spur and tarsus of *Neoneurus diabolicus* female.

venation of fore wing distinctly sclerotized and appearing yellowish brown from below [in very old specimens there may be some fading that will render this couplet difficult] ..... *Neoneurus mantis*, new species

– Wings indistinctly infumate; nonmarginal venation of fore wing weakly sclerotized and appearing white from below .... *Neoneurus masneri*, new species

17(12) Vertex finely granular 18

– Vertex finely transversely rugulose .... *Neoneurus auctus* (Thomson)

18(17) Clypeus and hind femur entirely yellow; Europe ..... *Neoneurus clypeatus* (Foerster) and *Neoneurus* viennense Giraud
– Clypeus black; hind femur yellow infused with dark brown and black; Mongolia .. .. *Neoneurus armatus* Tobias

Synopsis of *Neoneurus* Species

Neoneurus armatus Tobias, 1977

Neoneurus armatus Tobias, 1977.

Diagnosis.—Female with facial spinules distinct but short; spinules situated on thick tubercles that are nearly as long as antennal pedicel but distinctly shorter than antennal scape; fore tibial spur large and strongly curved, about as long as ⅓ tibia length, and slightly shorter than basitarsus length; anterior longitudinal carina of fore tibia produced into two thorn-like projecting spines, one medially and one basally.

Male with vertex finely granular; facial markings black; clypeus black; tegula dark brown; hind coxa dark brown; hind femur dark brown; fore tibial spur strongly curved and about as long as ¾ basitarsus length.

Material examined.—1 holotype female, Mongolia: Eastern Aimak, Derkmin-Tsagan-Obo, 60 km. ENE Bayan-Burda, 2.VIII.1976, M. Koslov [ZIL]; 1 male, Mongolia: Uvs Aimak, Sandgebiet Altan els, 35 km WNW von Somon Tes, 1400 m, Exp. Dr. Z. Kaszab, 1986, Nr. 1007, 23.VI.1968, det. *Neoneurus viennense* Papp, 1974 [TMB].

Distribution.—Mongolia.

Hosts.—Unknown.

Remarks.—The head and fore leg of the holotype were figured by Tobias (1977). *Neoneurus armatus* is quite distinctive in being the only known palearctic species with a medial spine projecting from the anterior longitudinal carina of the fore tibia. In this regard, *Neoneurus armatus* is similar only to the nearctic species *Neoneurus portalensis* and *Neoneurus spinarius*, however, these species both have the tibial spines more extremely developed than in *armatus*. Tobias (1977, Fig. 5a) shows the female facial spinules to be curved to the left in an asymmetrical fashion. This is probably an abnormal specimen in this regard, as other *Neoneurus* species typically have straight spines or spinules. Most likely, the spinules of this specimen were bent soon after emergence, while the cuticle was still soft.

The single male specimen included here is assumed to be *armatus* since this is the only species known from Mongolia. It was compared with the male holotype of *viennense* and is definitely distinct from that species. It could not be compared with *Neoneurus curvicalcar* Belokobylskij, the only other Asian species, for which the male is unknown.

Neoneurus auctus (Thomson), 1895

Elasmosoma aucta Thomson, 1895; transferred to *Neoneurus* by Bengtsson, 1918.
Neoneurus halidaii Marshall, 1897; synonymized by Bengtsson, 1918.
Neoneurus bistigmaticus Morley, 1909; synonymized with *halidaii* by Morley, 1914a.

Diagnosis (modified from Bengtsson, 1918).—Female with head finely transversely rugulose; facial spinules absent; fore tibia without a distinct basal longitudinal carina along inner margin or a subbasal protuberance on anterior margin; fore tibial spur small and only slightly curved, distinctly shorter than ½ tibia length; fore basitarsus about equal in length to fore tibia.

Males with vertex finely transversely rugulose; clypeus and antenna dark brown; tegula dark brown; wings lightly infumate; submarginal venation very pale; hind coxa mostly black; hind femur yellow; fore tibial spur about ¾ as long as basitarsus, only slightly curved.

Final instar larva (Čapek 1970) with mandibles wedge-shaped, about the same size as maxillary palpus; hypostoma much shorter than stipital sclerite; hypostomal spur lightly indicated; labial sclerite almost

square; antenna disc-shaped; setae beneath labial sclerite short.

Material examined.—1 female lectotype of *Neoneurus auctus* (Thomson) (here designated), "Sm, Bhn, 1975 604, 1991 179" [pinned, hind leg and metasoma glued on separate card] [ZML]; 1 male paralectotype of *Neoneurus auctus* (Thomson) (here designated), same data as lectotype [ZML]; 1 male, Bengtsson collection [ZML]; 1 male, Norwegen Coll. Strand, Hatfjelddahl, Coll. Schmiedeknecht [ZMH]; 2 females, Wisenburg, 25.VI.16, Bischoff [ZMH]; 1 female, Mizdroy, July 28, Bischoff S.G. [ZMH]; 1 male, Finkenkrug, 2.9.28, Bischoff S.G. [ZMH]. 1 male paralectotype of *Neoneurus halidaii* Marshall, 1897 [TMB]. 1 female holotype of *Neoneurus bistigmaticus* (Morley), 1909, card-mounted, B.M. Type Hym. 3c1287, Weybridge, July 1906 [BMNH].

Distribution (according to Shenefelt 1969).—Austria, Czechoslovakia, England, Finland, Norway, Poland (Silesia), Sweden.

Seasonal occurrence.—In England, occurring from June 15 through July 21 (Donisthorpe, 1909b).

Hosts.—*Formica rufa* Linnaeus, according to Morley (1909) and Donisthorpe (1909a, b) [as *bistigmaticus*]. Donisthorpe (1909a, b, 1927) noted that females are found flying over nests of the host ant and described how they hover over the ant and dart rapidly to oviposit between the metasomal segments.

Remarks.—Wings, fore leg, and metasoma were figured by Bengtsson (1918), fore wing by Tobias (1966), and larval mouthparts by Čapek (1970). *Neoneurus auctus* is most similar to *Neoneurus mantis* and *Neoneurus pallidus* in the form or the fore tibial spur, which is relatively short; however, these species can be separated by differences in the length of the tibia relative to the basitarsus and several other characters (see key). *Neoneurus auctus* females are very distinct from all other known *Neoneurus* species in lacking facial spinules and having a relatively unspecialized fore tibia without a distinct basal longitudinal carina along inner margin or a subbasal protuberance on anterior margin. Although the fore femora is somewhat compressed and the tibial spur of moderate size, it is unclear based on morphology alone whether the fore leg of this species may have a raptorial function as is hypothesized for other *Neoneurus* species.

Neoneurus clypeatus (Foerster), 1862

Ecclites clypeatus Foerster, 1862; transferred to *Neoneurus* by Ashmead, 1900.

Diagnosis.—Female unknown.

Male with clypeus and antenna pale yellowish white; face brown; vertex granular; tegula yellowish white; wings hyaline, venation very pale; hind coxa and femur yellow.

Material examined.—1 male holotype, Germany, "Aachen, 17, 279, Frst, clypeatus Frst, Zool. Mus. Berlin, *Ecclites clypeatus* Foerster det. C. van Achterberg 1979, *Neoneurus clypeatus* (Foerster) type series checked C. van Achterberg 1979, sen. syn. of *Neoneurus viennense* (Giraud) det. C. van Achterberg 1979."

Distribution.—Aachen, Germany.

Hosts.—Unknown.

Remarks.—This species was not treated by Bengtsson (1918). Muesebeck (1931) compared the holotypes of *Ecclites clypeatus* Foerster and *Neoneurus halidaii* Marshall (= *auctus*) and concluded that Ashmead (1900) was correct in synonymizing *Ecclites* with *Neoneurus*. Since Muesebeck did not synonymize the two species, it can only be assumed that he considered *clypeatus* to be distinct from what is here treated as *auctus* (Thomson).

Neoneurus clypeatus poses a real taxonomic difficulty, since it is known only from a male holotype which is in poor condition. Both antennae are broken before the apices and both fore legs are missing. The body is discolored and faded with age and it is difficult to acertain its original condition.

Specimen labels indicate that the holotype was studied by C. van Achterberg in 1979 and determined to be conspecific with *Neoneurus viennense* (Giraud). However, direct comparison of the male holotypes of both species indicates that although they are morphologically very similar, there are some subtle differences that suggest that they may be different valid species. The basal flagellomeres of *Neoneurus clypeatus* are shorter and less densely setose than in *Neoneurus viennense,* and the hind tibial spurs and hind tarsomeres are shorter than in *Neoneurus viennense.* The antennae, body, and hind coxa of *Neoneurus clypeatus* are much more pale than in *Neoneurus viennense,* but this could be partly due to aging of the specimen. The *Neoneurus clypeatus* holotype has quite obviously faded with age, but it is difficult to attribute these differences entirely to aging, since the *Neoneurus viennense* holotype is nearly as old. It seems advisable to retain these as separate species until topotypic females of *clypeatus* are discovered for comparison.

Neoneurus curvicalcar Belokobylskij

Neoneurus curvicalcar Belokobylskij, 1986.

Diagnosis.—Female with facial spines long and distinct, about as long as antennal pedicel, but shorter than antennal scape; facial spines separated by a distance equal to scape width; subbasal tibial protuberance not falcate; fore tibial spur large and strongly curved, about as long as ½ tibia length, and slightly shorter than basitarsus length.

Male unknown.

Material examined.—1 female holotype, USSR, Eastern Kazakhstan, 8 km NW Verkhubinka, Uba region, 11.VIII.1983, Belokobylskij [ZIL].

Distribution.—Eastern Kazakhstan.

Hosts.—Unknown.

Remarks.—The head, fore wing, fore leg, and first tergum were illustrated by Belokobylskij (1986). This species is very similar to *Neoneurus viennense* (Giraud), except that the subbasal tibial protuberance is not falcate and the facial spines are separated by a distance equal to scape width. In *Neoneurus viennense* the subbasal tibial protuberance is falcate and the facial spines are separated by a distance distinctly greater than the scape width.

***Neoneurus diabolicus* Shaw, New Species**
Figs. 2, 6, 14, 24 & 28

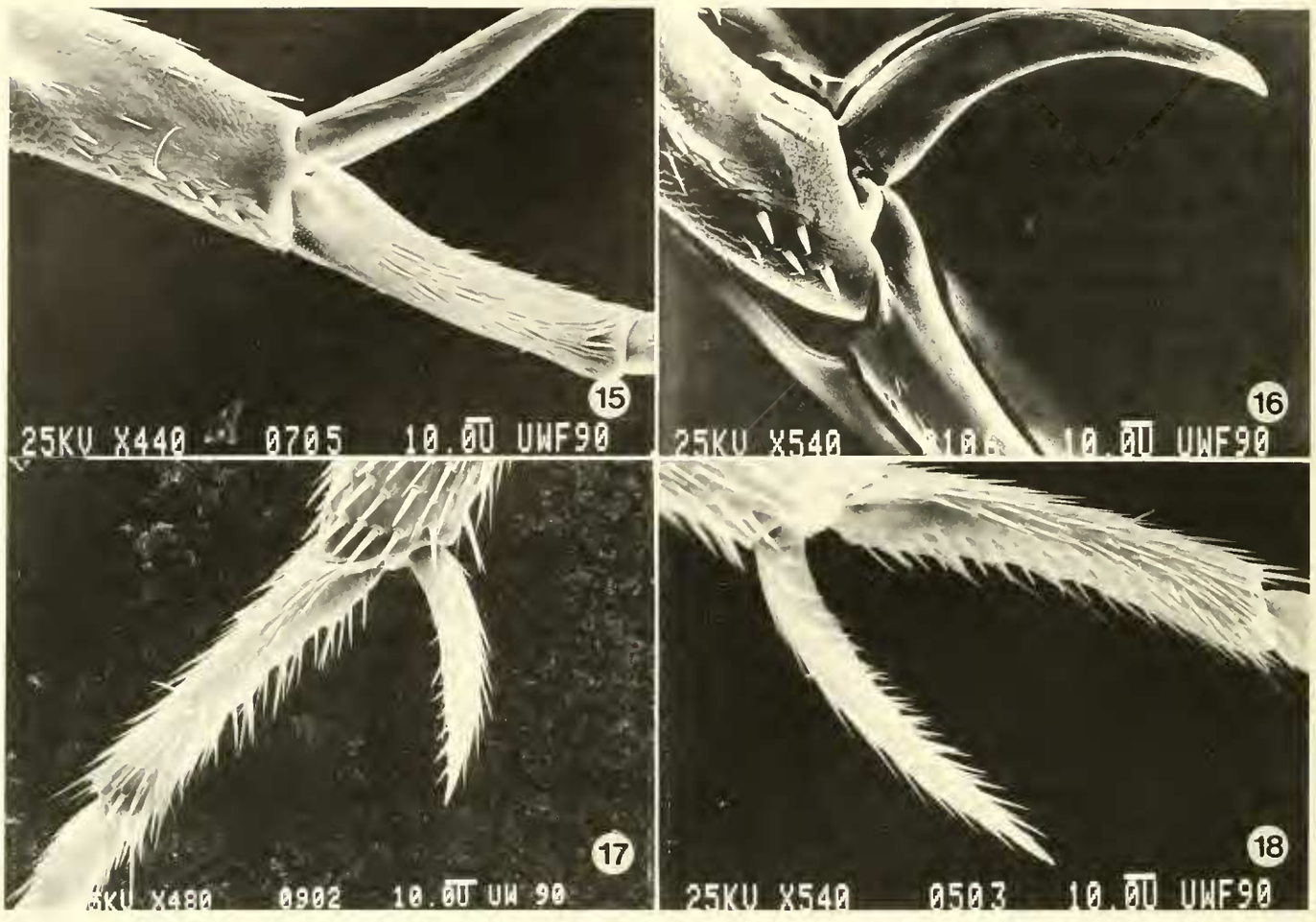
Holotype.—Female, United States: North Dakota, McHenry County, Denbigh Exp. Forest, Sec. 36, T. 156, R. 78, 20–21 August 1969, M. E. McKnight, Collector, Malaise trap, Hopk. 53988Q [USNM].

Description of holotype female.—Body length 2.67 mm; fore wing length 1.97 mm.

Color: Lower parts of head pale yellowish white, except apex of mandible dark reddish black; ocellar triangle, temple, vertex, and occiput black; scape, pedicel, and flagellomere 1 yellowish white, flagellum otherwise gradually darker brown apically; compound eye dull silvery black; mesosoma marked with yellowish brown on mesonotum anteriorly, laterally, and medially, pronotum marginally, and subalar area of mesopleuron; prosterna, tegula, wing base, and costa basally pale yellowish white; legs entirely pale yellowish brown except trochantelli and pulvilli brown; wing venation pale yellowish brown to hyaline, except remainder of costa and stigma dark brown; wing membrane very lightly infumated with brown; mesosoma otherwise black (especially mesopleuron and propodeum); metasoma pale yellowish brown, except antero-medial area of tergum 1 infused with black.

Head: Minutely granulate except short smooth furrow anterior to median ocellus; facial spines long and distinct, longer than antennal pedicel, and about as long as antennal scape; malar space/eye height = 0.11; ocell-ocular distance/lateral ocellus diameter = 1.8; ocellar triangle slightly raised.

Mesosoma: Minutely granulate except mesopleuron medially and propodeum medially and posteriorly rugulose; mesopleu-



15. Fore tibial spur and basitarsus of *Neoneurus portalensis* female.
16. Fore tibial spur and basitarsus of *Neoneurus viennense* female.
17. Fore tibial spur and basitarsus of *Neoneurus mantis* male.
18. Fore tibial spur and basitarsus of *Neoneurus portalensis* male.

ron posteriorly and metapleuron medially nitid; fore tibial spur large and strongly curved, as long as ¾ tibia length, and as long as fore basitarsus.

Metasoma: Tergum 1 and tergum 2 minutely granulate; metasoma otherwise nitid.

Paratype female.—Essentially as in holotype except right fore wing removed for study (mounted on microscope slide for study by Marsh et al. 1987); ocell-ocular distance/lateral ocellus diameter = 1.9.

Paratype males.—Face black, scape and pedicel brown; tegula pale yellow or whitish; hind coxa mostly yellowish brown or, at most, infused with brown basally; wings clear or only lightly infumate.

Paratype data.—1 female, same data as holotype except collected 11–17 July, Hopk. 53988H; one male, same data as holotype except collected 28–31 July, Hopk. 53988L; one male, same data as holotype except collected 22–25 August, Hopk. 53988P [USNM, RMSEL]. The following data are from the associated Hopkins card file: "Collections from Malaise trap installed 21 May 1969 at approximate center of NW Sec. 36, 60 feet east of windbreak and 50 feet north of its south end. Overstory largely cottonwood. Trap dismantled 15 October 1969."

Remarks.—The facial spines of the female are much larger than in any other *Neoneurus* species (Fig. 28), and the fore tibial spur is larger than in any other North American *Neoneurus* species (Fig. 14).

Etymology.—From the Latin *diabolus* meaning devil or evil spirit; in reference to

the pair of long facial spines of the female that give her a decidedly devilish appearance.

Neoneurus mantichorus Shaw, New Species

Holotype.—Female, United States: Georgia, Rabun County, Satolah, 2500 feet, 4 July 1957, W.R.M. Mason [CNC].

Description of holotype female.—Body length 3.03 mm; fore wing length 2.12 mm.

Color: Lower parts of head pale yellowish white, except apex of mandible dark reddish black; ocellar triangle, temple, vertex, and occiput black; scape and pedicel yellowish white; flagellum pale brown basally, gradually darker brown apically; compound eye dull silvery black; mesosoma marked with yellowish brown on mesonotum anteriorly, laterally, and medially, pronotum marginally, subalar area of mesopleuron, and mesopleuron ventrally; prosterna, tegula, wing base, and costa basally pale yellowish white; legs entirely pale yellowish white basally to pale yellowish brown apically, except trochantelli apically and pulvilli brown to black; wing venation pale yellowish brown to hyaline, except remainder of costa and stigma dark brown; wing membrane very lightly infumated with brown; mesosoma otherwise dark reddish brown to black (especially mesopleuron medially and propodeum); metasomal tergum 1 and tergum 2 basally dark reddish brown to black; metasoma otherwise pale yellowish brown irregularly infused with black.

Head: Minutely granulate except median area of frons between antennal insertions minutely rugulose; facial spines long and distinct, longer than antennal pedicel, but shorter than antennal scape; face with a short median tubercle just above paired facial spines; malar space/eye height = 0.09; ocellocular distance/lateral ocellus diameter = 2.0; ocellar triangle only very slightly raised.

Mesosoma: Minutely granulate except pronotum dorsally, mesopleuron medially, metapleuron ventrally, and propodeum medially and posteriorly rugulose; mesopleuron posteriorly nitid; fore tibial spur large and strongly curved, as long as ¾ tibia length, and as long as fore basitarsus.

Metasoma: Tergum 1 basally and medially and tergum 2 basally minutely rugulose; metasoma otherwise minutely granulate.

Remarks.—Known only by the holotype female, this species is very similar to *Neoneurus diabolicus*; however, *mantichorus* has shorter facial spines and the fore tibia is longer and not so stout as in *diabolicus*.

Etymology.—From the Latin; a fabulous beast with a human face, lion's body, and a scorpion's tail.

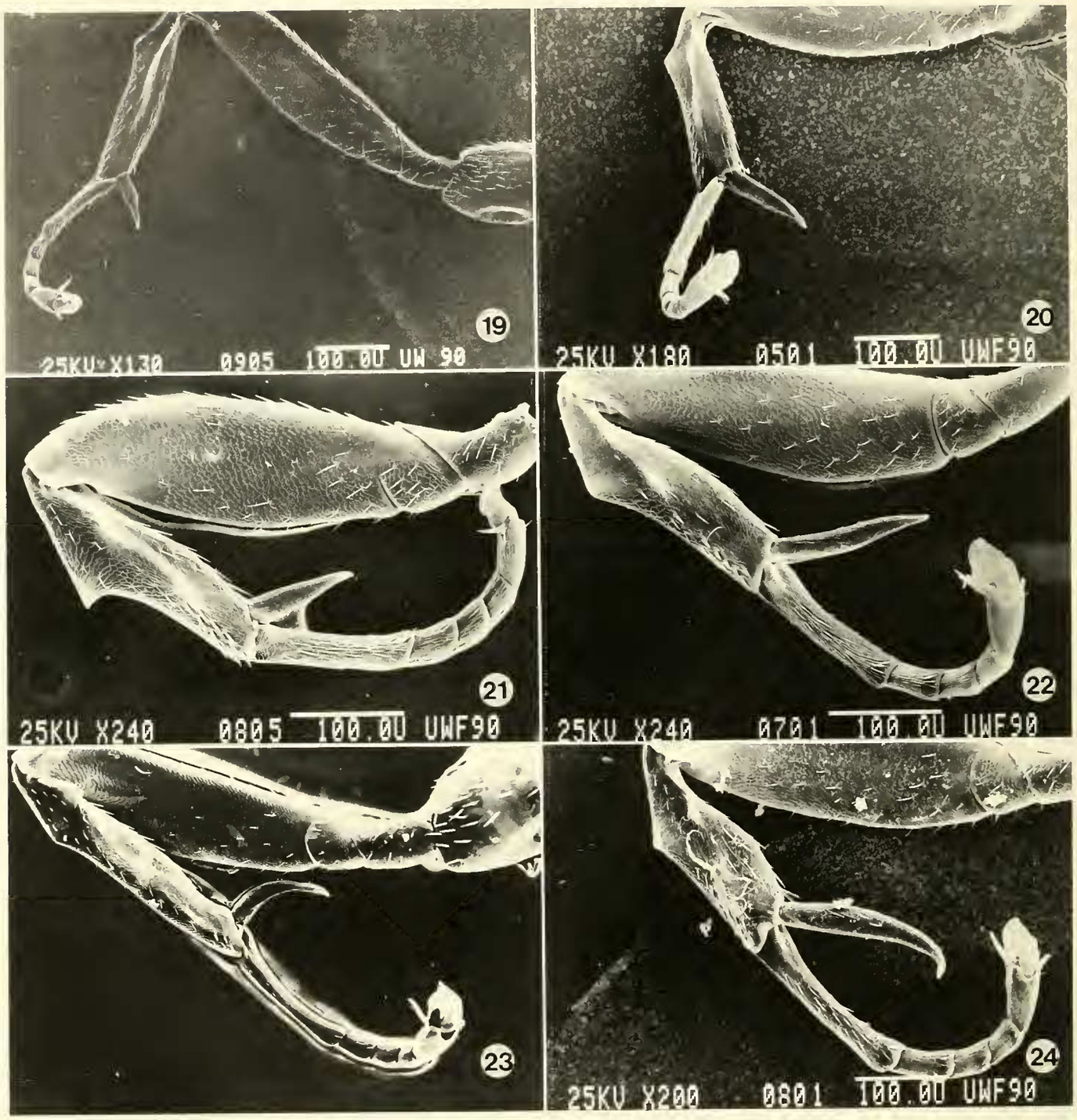
Neoneurus mantis Shaw, New Species

Figs. 1, 3, 9, 17, 19, 25, 26 & 27

Holotype.—Female, United States: Wyoming, Albany County, Medicine Bow National Forest, 0.5 mi. SW Lincoln Monument, montane meadow near mixed conifer/aspen forest, 27 June 1990, Scott R. Shaw, aspirated from grass stems near entrance to ant mound [RMSEL].

Description of holotype female.—Body length 2.58 mm; fore wing length 1.97 mm.

Color: Lower parts of head pale white, except apex of mandible dark reddish black; frons medially, ocellar triangle, temple, vertex, and occiput black; scape pale yellowish brown; pedicel brown; flagellum dark brown to black; compound eye dull silvery gray; mesosoma black except prosterna white; tegula, wing base, and costa basally pale yellowish brown; fore coxa and trochanter white, remainder of leg pale yellowish brown except apical tarsomere, claws, and pulvillus dark brown; middle coxa and trochanter white, remainder of leg pale yellowish brown except tarsi dark brown; hind coxa white infused with black basally, hind trochanter white, hind femora yellowish brown; hind tibia and tarsi dark brown; wing venation pale brown to hyaline, except remainder of



19. Fore leg of *Neoneurus mantis* female.
20. Fore leg of *Neoneurus masneri* female.
21. Fore leg of *Neoneurus spinarius* female.
22. Fore leg of *Neoneurus portalensis* female.
23. Fore leg of *Neoneurus viennense* female.
24. Fore leg of *Neoneurus diabolicus* female.

costa and stigma dark brown; wing membrane deeply infumated with brown; metasomal tergum 1 and extreme base of tergum 2 black; remainder of metasoma yellowish brown irregularly infused with black along posterior margins of terga, on laterotergites, and sterna.

Head: Minutely granulate except median area of frons between antennal insertions minutely rugulose; facial spinules minute, distinctly shorter than ½ antennal pedicel length, although spinules placed on raised tubercles; face with a short median tubercle just above paired facial spines; malar space/

eye height = 0.13; ocell-ocular distance/lateral ocellus diameter = 1.78.

Mesosoma: Minutely granulate except mesopleuron medially and posterior face of propodeum rugulose, postero-dorsal area of mesopleuron nitid; fore tibial spur small and only slightly curved, distinctly shorter than ½ tibia length.

Metasoma: Tergum 1 and antero-medial area of tergum 2 minutely rugulose; metasoma otherwise minutely granular to nitid.

Paratype females.—Wyoming specimens essentially as in holotype female except body length 2.33–3.12 mm; fore wing length 1.67–1.97 mm; malar space/eye height = 0.19–0.22; ocell-ocular distance/lateral ocellus diameter = 1.64–1.70. Oregon series essentially as in Wyoming paratypes except pronotum laterally, subalar area of mesopleuron, hind tibia, hind tarsus, and sometimes mesonotum antero-laterally yellowish brown; mesosoma more extensively infused with black along posterior margins of terga; facial spinules distinctly longer than in Wyoming population. Alberta specimen with similar mesosomal markings to Oregon series; however, metasomal color lighter, as in Wyoming specimens; facial spinules distinctly longer than in Wyoming population, about equal to those of Oregon series.

Paratype males.—Wyoming specimens with tegula dark brown; hind coxa mostly black; wings distinctly infumate. Alberta specimens with tegula lighter brown; wings less deeply infumate.

Paratype data.—1 female, 1 male, same data as holotype; 5 females, 2 males, same data as holotype except 28 June 1990; 2 females, 2 males, same data as holotype except 29 June 1990; 5 females, 2 males, same data as holotype except 2 July 1990; 2 males, same data as holotype except 5 July 1990, yellow pan trap; 2 males, same data as holotype except 9 July 1990, yellow pan trap; 1 male, same data as holotype except 12 July 1990, yellow pan trap; 2 females, same data as holotype except 2 August 1990; 3 females, same data as holotype except 8 August 1990; 4 females, same data as holotype except 26 June 1991; 1 female, same data as holotype except 27 June 1991; 1 female, same data as holotype except 19 July 1991 [RMSEL, USNM, TAMU]. 1 female, **United States, California:** Marin County, Alpine Lake, Lily Pond, 1500', 23 June 1970, D.D. Munroe, Malaise trap [CNC]. **Oregon:** 3 females, Sixes R. Valley, 1–11 August 1985, Myrtle woods, L. Masner [CNC]; 1 female, Pinehurst, 29 June 1978, H.&M. Townes [AEI]; 2 females, Ochoco Creek, 8–14 July 1978, H.&M. Townes [AEI]; 1 female, 2 males, Grant County, Aldrich Mountains, 12 August 1987, T.R. Torgersen [AEI]; 1 female, Union County, Mt. Emily, 21 August through 1 September 1987, T.R. Torgersen [AEI]; 1 female, same data except collected 14 June [AEI]; 1 male, same data except collected 6–21 August (aberrant specimen with pale tegula) [AEI]. **Canada, Alberta:** 1 female, Banff, Eisenhower Junction, 4700', 10 July 1962, Mason [CNC]; 3 males, Kananaskis, For. Exp. Stn. Seebe, 21–23 June 1962, W.R.M. Mason [CNC]; 1 male, Onefour, 49.6, 110.24, 7 June 1955, J.R. Vockeroth [CNC]; 1 male, McMurray, 13 July 1953, W.J. Brown [CNC]. **British Columbia:** 1 male, Vancouver Island, Teanook Lake, August 1984, Malaise trap, M. Sharkey & K. Johnson [CNC]; 6 females, 1 male, Blind Bay, June 1987, C.A. Elsey [CNC].

Hosts.—In Wyoming associated with, but not reared from, *Formica podzolica* Francoeur. Host ants build large, low mounds with multiple entrances, commonly near the base of sagebrush bushes. Mounds typically have many protruding grass stems.

Remarks.—Specimens of the Wyoming population are notably homogeneous in their color patterns and morphology. The single female from California does not differ notably from the Wyoming series, nor do those from British Columbia. The Oregon populations differ slightly in color pattern by having some lighter mesosomal markings and a darker metasoma; however, in mor-

phology they are quite close to the Wyoming specimens except that the facial spinules are slightly larger. The Ochoco Creek population, in particular, is unusual in having the facial spines somewhat lower on the face, the anterior longitudinal carina of the fore tibia is raised into a distinct lamella, and the fore tibial spur is longer than usual. These differences being rather slight, I am inclined to interpret them as intraspecific variation, although it is possible that some of the Oregon populations are actually separate sibling species. In the absence of host or behavioral data on the Oregon populations, there is little justification for separating possible sibling species at this time. Likewise, there are some minor differences in the Alberta specimens in body color and size of the facial spinules.

Behavior.—*Neoneurus mantis* was found in Wyoming consistently in close association with three mounds of *Formica podzolica* Francoeur in a montane meadow of the Medicine Bow National Forest. Females were found hovering slowly near the nest entrances, or more commonly, perching for extended periods of time on grass stems near the nest entrances at a height of about 2.5 cm. The fore legs of the female wasp were often held in an upraised, mantid-like, position while at rest. When *Neoneurus* were present, the ants were very active near the mound, and many workers appeared to be patrolling the grass stems. *Neoneurus* were not found at the mounds during periods of low ant activity, and ants were only noted to patrol stems on the days when *Neoneurus* were present. When disturbed by an approaching ant, the *Neoneurus* female quickly took to flight and hovered nearby (2.5 cm or less) paralleling the movements of the ant. In such encounters, the ant appeared to perceive the presence of the parasitoid, actively chasing it and snapping with its mandibles. Such encounters were common, usually lasting from a few seconds to 15 seconds or more, but most often oviposition did not occur. In most cases the encounter ended by the ant running rapidly away, and the female wasp slowly hovered to a new position. In some cases the female returned to the same perch. Oviposition was observed during three such encounters. Each time the female hovered close, paralleling the movements of the ant for about five to ten seconds, when the ant suddenly moved from the ground up a grass stem. At about three to five cm height the ant slowed to reverse its position, at which point the wasp rapidly darted down and alighted on the metasoma of the ant for a period of less than one second. The female wasp then quickly retreated away 5 cm or more, and hovered slowly for about one minute before taking a new perch. Following oviposition, the ants became very agitated and quickly ran away in an erratic fashion. Only one was captured, however, it died in the laboratory within 48 hours and no parasitoid ever emerged from it. Although female wasps were found to be active both in mornings and afternoons, males were found near the ant mounds only during morning hours. Males also perched on grass stems, but only for shorter periods of time and at much greater heights (7–15 cm above the ant mound). Males were also found at greater distances from the ant mound (45–60 cm away), whereas females always were within 5–10 cm of the nest entrances.

Etymology.—From the Greek for soothsayer; in reference to the fore legs of the female, which are often held in an upraised, mantid-like position while at rest.

Neoneurus masneri Shaw, New Species
Figs. 12 & 20

Holotype.—Female, United States: Washington, Ashford, W. Mt. Rainlor [= Ranier] National Park, 1–14 August 1985, L. Masner [CNC].

Description of holotype female.—Body length 2.15 mm; fore wing length 1.67 mm.

Color: Lower parts of head pale yellowish white, except apex of mandible dark reddish black; frons medially, ocellar triangle, tem-

ple, vertex, and occiput black; scape, pedicel, and extreme base of flagellomere 1 yellowish white; flagellum otherwise dark brown; compound eye silver; mesosoma black except pronotum marginally, mesonotum laterally, and subalar area of mesopleuron yellowish brown; prosterna yellowish brown; tegula, wing base, and costa basally pale yellowish white; legs entirely pale yellowish white basally to pale yellowish brown apically, except pulvilli dark brown; wing venation pale yellowish brown to hyaline, except remainder of costa and stigma dark brown; wing membrane very lightly infumated with brown; metasomal tergum 1 and tergum 2 basally black; metasoma otherwise pale yellowish brown banded with dark brown along basal and apical margins of terga.

Head: Minutely granulate; facial spines long and distinct, longer than antennal pedicel and as long as antennal scape; spines close together, the distance between their tips about equal to width of median ocellus; face with a short median tubercle just above paired facial spines; malar space/eye height = 0.16; ocell-ocular distance/lateral ocellus diameter = 2.11.

Mesosoma: Minutely granulate except pronotum laterally, mesopleuron anteromedially, metapleuron ventrally, and posterior face of propodeum rugulose; posterodorsal area of mesopleuron nitid; fore tibial spur large, longer than ½ tibia length and as long as fore basitarsus; spur relatively straight, curved only in its apical ¼.

Metasoma: Tergum 1 and antero-medial area of tergum 2 granular; metasoma otherwise minutely granular to nitid.

Paratype female.—Essentially as in holotype female except body length 2.12 mm; fore wing length 1.79 mm; malar space/eye height = 0.18; lateral aspects of metasoma less rugulose and more granular; metasoma less distinctly banded and more deeply infused with brown (probably due to postmortem discoloration).

Paratype males.—Head except labrum and mandible, metasoma, and metasomal tergum 1 black; labrum and mandible yellowish white; remainder of metasoma and all coxae dark brown; legs otherwise yellowish brown; wings lightly infumate; submarginal venation very pale.

25. Apical flagellomere of *Neoneurus mantis* female antenna.

26. Apical flagellomere of *Neoneurus mantis* male antenna.

Paratype data.—2 males, same data as holotype female [CNC]. 1 male, **Washington:** Grant Co., Potholes Research Station, S. Mores Lake, 27 August 1985, Finnamore & Thormin [CNC]. 1 female, **Oregon:** Corvallis, 3 October 1980, H.K. Townes [AEI].

Remarks.—*Neoneurus masneri* is closest to *Neoneurus diabolicus* in having very large facial spines and fore tibial spur; however, the facial spines are much closer together than in *diabolicus* and the fore tibial spur is much straighter (Figs. 12, 20). Except for their paler wings, males of this species are very similar to those of *Neoneurus mantis,*

and males are best identified by association with females.

Etymology.—Named for Lubomir Masner, renowned hymenopterist and collector of the holotype.

Neoneurus pallidus Shaw, New Species

Figs. 4, 10, 29 & 30

Holotype.—Female, United States: Colorado, Baca County, Springfield, 20–25 July 1988, R. Wharton, Malaise trap, high plains [TAMU].

Description of holotype female.—Body length 2.16 mm; fore wing length 1.85 mm.

Color: Lower parts of head pale white, except apex of mandible dark reddish black; frons medially, ocellar triangle, temple, vertex, and occiput black; areas of head bordering black markings grading from black through yellowish brown to white; scape, pedicel, and extreme base of flagellomere 1 white, flagellum otherwise dark brown; compound eye silver; mesosoma extensively marked with yellowish brown (paler laterally and ventrally), especially mesonotum anteriorly, scutellar disc, pronotum laterally, subalar area of mesopleuron, and mesopleuron ventrally; prosterna, tegula, wing base, and costa basally pale yellowish white; fore and middle legs white; hind leg white basally, grading to pale yellowish brown apically; wing venation pale brown to hyaline, except remainder of costa and stigma dark brown; wing membrane very lightly infumated with brown; mesosoma otherwise black (especially mesopleuron medially and propodeum); metasoma pale yellowish brown, except tergum 1 and extreme base of tergum 2 darker yellowish brown; tergum 1 irregularly infused with black medially.

Head: Minutely granulate, especially on vertex; facial spinules small but distinct, slightly shorter than ½ antennal pedicel length; malar space/eye height = 0.10; ocell-ocular distance/lateral ocellus diameter = 1.89.

Mesosoma: Minutely granulate except pronotal furrow and posterior face of propodeum rugulose, postero-dorsal area of mesopleuron nitid; fore tibial spur small and only slightly curved, distinctly shorter than ½ tibia length.

Metasoma: Tergum 1 and antero-medial area of tergum 2 minutely rugulose; metasoma otherwise nitid.

Paratype females.—Colorado specimens essentially as in holotype except body length 2.88–2.89 mm; fore wing length 1.91–1.97 mm; malar space/eye height = 0.12–0.14; ocell-ocular distance/lateral ocellus diameter = 1.80–2.0; tergum 1 lighter in color, not distinctly marked with black; postero-lateral corners of propodeum infused with reddish brown. Virginia specimen essentially as in holotype except body length 2.94 mm; fore wing length 2.12 mm; malar space/eye height = 0.16; ocell-ocular distance/lateral ocellus diameter = 2.10; mesosternum black; mesopleuron rugulose medially; tibial carina raised submedially; spiracles of metasomal tergum 1 slightly more prominent.

Paratype males.—Face, scape, and sometimes pedicel marked with pale yellowish brown; tegula pale yellow or whitish; hind coxa mostly yellowish brown or, at most, infused with brown basally; wings clear or only lightly infumate.

Paratype data.—1 female, 5 males, same data as holotype; 1 female, same data as holotype except collected 14–20 July, H. Mann [TAMU, RMSEL]. **Canada, Ontario:** Bergland, 3 August 1960, S.M. Clark [CNC]. **United States, Maryland:** 1 male, Plummer's Island, 26 June 1915, R.C. Shannon collector [USNM]; 1 male, Cabin John, September 1915 [USNM]. **Michigan:** 1 male, Midland County, 16 August 1941, R.R. Driesbach [AEI]; 1 male, Midland county, 24 June 1959, R.R. Dreisbach [USNM]. **North Carolina:** 1 male, Highlands, Whiteside Mountain, 20 July 1957, W.R. Richards [CNC]; 1 male, Mt. Mitchell, 6800′, 12 August 1957, J.G. Chillcott [CNC]; 1 female, Pink Beds, 21 July 1952, G. & L.

Townes [AEI]; 2 males, Wagon Road Gap, 21 July 1952, G. & L. Townes [AEI]. **Virginia:** 1 male, Fairfax, Dead Run, 8 May 1915, R.C. Shannon collector, at light [USNM]; 1 female, 1 male, Hawksbill, Shenandoah National Park, 3600–4050′, 7 June 1962, J.R. Vockeroth [CNC].

Remarks.—Most similar to *Neoneurus mantis* but differing most obviously by much more extensive light yellowish brown markings on the mesosoma and metasoma of *Neoneurus pallidus* females (Fig. 29). Males are unusual in having pale facial markings (Fig. 30), which may be a slight expression of an otherwise female trait (all known *Neoneurus* females have a pale face). Morphologically *Neoneurus pallidus* is very similar to *Neoneurus mantis* but there are subtle differences in the form of the female fore legs (Figs. 9, 10). The basitarsus is somewhat shorter and thicker in *pallidus*, and the tibial spur is less tapered at the apex. *Neoneurus mantis* has a depression in the female fore coxa that articulates with the prosternum (Fig. 19) and this depression does not appear to be present in *pallidus*, but this is a cryptic character requiring further study.

Etymology.—From the Latin for ashen or pale.

Neoneurus portalensis Shaw, New Species

Figs. 7, 13, 15, 18 & 22

Holotype.—Female, United States: Arizona, Portal, 18 September 1987, H.& M. Townes [AEI].

Description of holotype female.—Body length 2.79 mm; fore wing length 1.88 mm.

Color: Head entirely pale yellowish white, except apex of mandible dark reddish black and ocellar triangle black; scape, pedicel, and flagellomeres 1–3 yellowish white, flagellum otherwise gradually darker brown apically; compound eye mottled silvery gray with black patches; mesosoma mostly pale orangish yellow anteriorly, except pronotum anteriorly, mesonotum posteriorly, mesopleuron and mesosternum anteriorly irregularly infused with black; metanotum, metapleuron, and propodeum black; legs entirely pale yellowish white except pulvilli, hind tibia and tarsus brown; wing venation brown; wing membrane very lightly infumated with brown; metasoma pale orangish brown, irregularly infused with black.

Head: Minutely granulate; facial spinules distinct but short; spinules situated on thick tubercles that are nearly as long as antennal pedicel but distinctly shorter than antennal scape; malar space/eye height = 0.08; ocell-ocular distance/lateral ocellus diameter = 1.82.

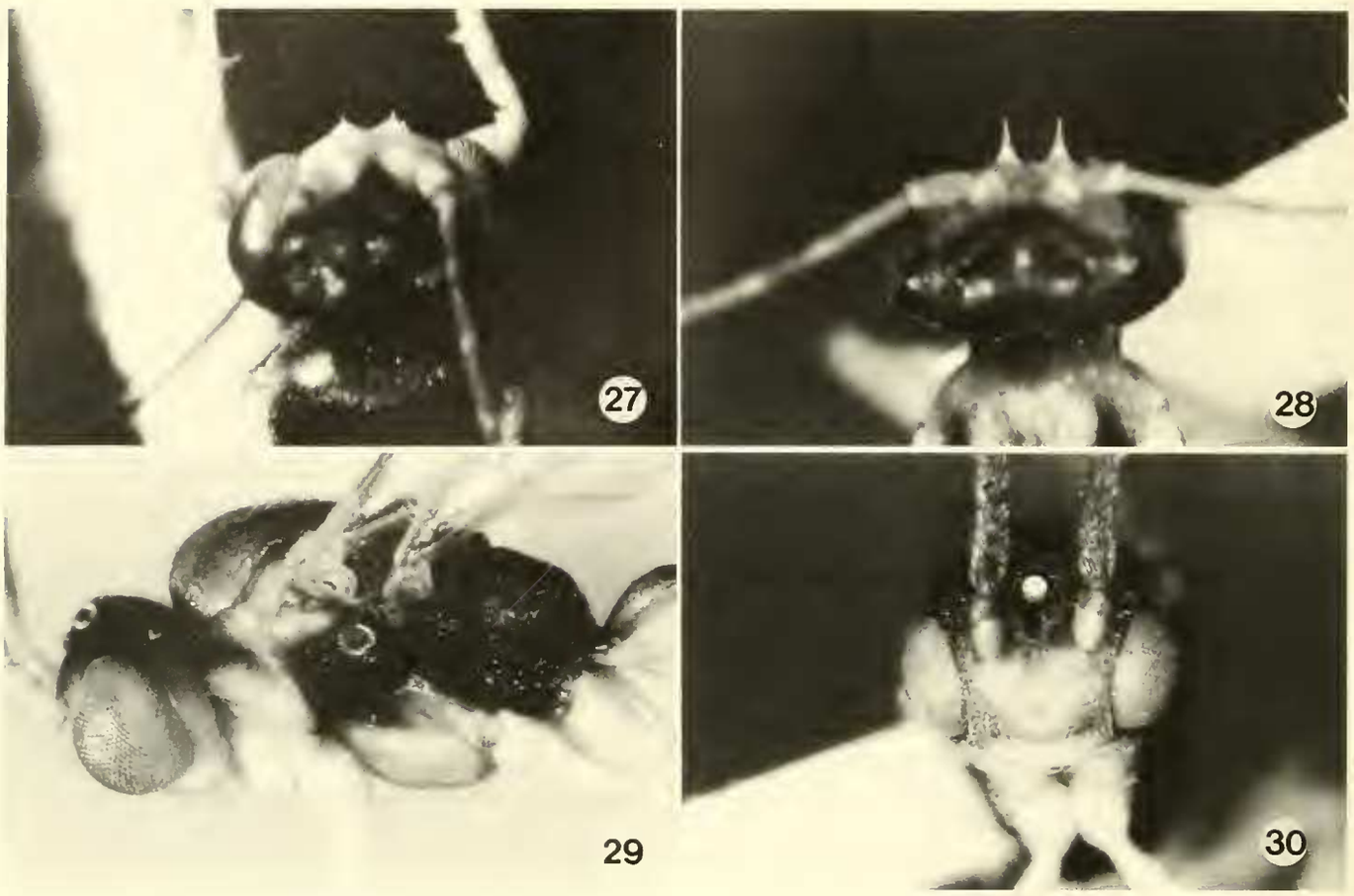
Mesosoma: Minutely granulate except mesopleuron medially and propodeum medially and posteriorly rugulose; mesopleuron posteriorly nitid; apex of fore femora produced in a short but distinct spine; fore tibial spur large and only gradually curved, nearly as long as ¾ tibia length, and nearly as long as fore basitarsus; anterior longitudinal carina of fore tibia produced into two thorn-like projecting spines, one medially and one basally.

Metasoma: Terga 1–3 distinctly granulate; metasoma otherwise minutely granulate to nitid.

Paratype males.—Body dark reddish brown to black except clypeus and tegula entirely pale yellowish white; legs pale yellowish brown except hind coxa infused with dark brown basally; wings very lightly infused with brown; fore tibial spur nearly as long as basitarsus.

Paratype data.—16 males, same data as holotype except collected 19 August to 13 September; 2 males, same data as holotype except collected 10–16 August 1974; 2 males, same data as holotype except collected 2–12 September 1976, J. van der Vecht [AEI, RMSEL].

Remarks.—*Neoneurus portalensis* is distinctive in having the anterior longitudinal carina of fore tibia produced into two thorn-like projecting spines, one medially and one basally (Figs. 7, 22). The only other known *Neoneurus* species with such an elaborately



27. Dorsal view of *Neoneurus mantis* female head showing profile of frontal spinules.
28. Dorsal view of *Neoneurus diabolicus* female head showing profile of frontal spinules.
29. Lateral view of *Neoneurus pallidus* female head and mesosoma showing pale coloration.
30. Anterior view of *Neoneurus pallidus* male head showing pale coloration.

formed fore tibia is *Neoneurus spinarius*; however, these two species are easily separated by differences in the form of the facial spines (see key). Males of *Neoneurus portalensis* have the fore tibial spur substantially longer than in other known *Neoneurus* species (Fig. 18).

Etymology.—Named for the type-locality.

Neoneurus spinarius Shaw, New Species
Figs. 8 & 11.

Holotype.—Female, United States: California, Lake Wohlford, 21 April 1974, H.& M. Townes [AEI].

Description of holotype female.—Body length 2.97 mm; fore wing length 1.97 mm.

Color: Lower parts of head pale yellowish white, except apex of mandible dark reddish black; frons medially, ocellar triangle, temple, vertex, and occiput black; frontal orbit of eye pale yellowish brown; scape and pedicel pale yellowish brown; flagellum dark brown; compound eye silver; mesosoma extensively marked with yellowish brown, especially mesonotum antero-laterally and postero-medially, scutellar disc, pronotum laterally, subalar area of mesopleuron, and mesopleuron postero-medially; prosterna, tegula, wing base, and costa basally pale yellowish white; legs pale yellowish white except hind tibia and tarsus brown; wing venation pale brown to hyaline, except remainder of costa and stigma dark brown; wing membrane very lightly infumated with brown; mesosoma otherwise dark reddish brown to black; metasomal tergum 1 and tergum 2 basally black; metasoma otherwise pale yellowish brown banded with dark brown along apical margins of terga 2–5.

Head: Minutely granulate except short

smooth medial furrow anteriad of median ocellus; facial spines very large and distinct, longer than antennal scape; malar space/eye height = 0.24; ocell-ocular distance/lateral ocellus diameter = 1.91.

Mesosoma: Minutely granulate except pronotum laterally, metapleuron ventrally, and propodeum medially and posteriorly rugulose; mesopleuron postero-dorsally nitid; apex of fore femora produced in a short but distinct spine; anterior longitudinal carina of fore tibia produced into two very large thorn-like projecting spines, one medially and one basally.

Metasoma: Tergum 1 and antero-medial area of tergum 2 minutely rugulose; metasoma otherwise minutely granular to nitid.

Remarks.—Known only by the holotype female, the fore tibia of *Neoneurus spinarius* is more extremely spinose and more elaborately developed than in any other *Neoneurus* species (Fig. 8). *Neoneurus spinarius* is similar to *Neoneurus portalensis* since these are the only two Nearctic species known to have a medial thorn-like spine on the fore tibia (a putative synapomorphy); however, the two species are easily separated as *spinarius* has both the facial and tibial spines more extremely developed.

Etymology.—Named for the remarkable spines on the fore tibia of this species.

Neoneurus viennense Giraud
Figs. 16 & 23

Elasmosoma viennense Giraud, 1871; transferred to *Neoneurus* by Bengtsson, 1918.

Diagnosis.—Female with facial spines long and distinct, about as long as antennal pedicel, but shorter than antennal scape; facial spines separated by distance distinctly greater than scape width; subbasal tibial protuberance falcate; fore tibial spur large and strongly curved, about as long as ½ tibia length, and slightly shorter than basitarsus length.

Male with vertex finely granular, clypeus yellowish brown, darker dorsally; tegula dark brown; wings lightly infumate; submarginal venation very pale; hind coxa mostly black; hind femur yellow; fore tibial spur about ¾ as long as basitarsus, only slightly curved.

Material examined.—1 male, holotype of *Elasmosoma viennense* Giraud, "vien." Museum Paris, coll. Giraud 1877 [MNHN]; 1 male, Bengtsson collection [ZML]; 1 female, Netherlands: Meyendel nr. The Hague, Bierlap, inner dunes, 25–31.VII.1974, A.P.M. van der Zon, det. van Achterberg, 1976 [RMSEL].

Distribution (according to Shenefelt, 1969).—Austria, Czechoslovakia, Denmark, Finland, Netherlands, Norway, Sweden, Yugoslavia.

Hosts.—*Formica rufa* Linnaeus, according to Fahringer (1935).

Remarks.—Originally described from a male specimen, the female of this species was first associated, described, and figured by Bengtsson (1918). The modified female fore leg and both male and female genitalia were figured by Tobias (1966). It is the only known European species with a large falcate fore tibial spur, and in this regard it is most similar to the new North American species, *Neoneurus diabolicus* and the Asian species, *Neoneurus curvicalcar*. *Neoneurus viennense* and *Neoneurus diabolicus* differ in a number of characters, most notably the size of the fore tibial spur and facial spines (see key). *Neoneurus viennense* and *Neoneurus curvicalcar* are more similar, but can be separated by differences in the position of the facial spines and the form of the subbasal tibial protuberance (see Remarks for *curvicalcar*).

Neoneurus spp. unassociated males

Material examined.—Specimens near *diabolicus* with pale tegula and dark facial markings: **CALIFORNIA:** 1 male, El Dorado county, Echo Lake, 17 July 1956, W.W. Middlekauff collector [USNM]; 1 male (possibly the male of *spinarius*), Julian, 26 May 1974; H.&M. Townes, "*Neoneurus* 1"

det. Townes 1981 [AEI]. **COLORADO:** 1 male, "1547," collection C.F. Baker [USNM]. **IDAHO:** 1 male, nr. Stanley, 2 August 1978, H.&M. Townes [AEI]. **MINNESOTA:** 1 male, Itasca State Park, 18 September 1927, S. Garthside, *Neoneurus* n.sp. det. Cushman [USNM].

Specimen near *mantis* with dark tegula, infumate wings, and dark facial markings: **WASHINGTON:** 1 male, San Juan Island (west side), 23 July 1944, R.D. Shenefelt, sweeping American vetch, *Neoneurus* sp. det. Muesebeck [AEI].

Specimen near *masneri* with dark tegula, pale wings, and dark facial markings: **WASHINGTON:** 1 male, Port Angeles, Mt. Pleasant District, 18 July 1945, R.D. Shenefelt, sweeping *Lathyrus torreyi* [AEI].

Remarks.—These specimens could not be assigned with certainty to any of the species recognized in this paper; however, they are interesting for their distributional data. They may represent variation and range extensions of the above species, or additional new species; it is difficult to assess their significance based on males alone.

Acknowledgments

Specimens for this study were provided by the following collections:

AEI	American Entomological Institute, Gainesville [D. Wahl]
BMNH	The Natural History Museum (British Museum), London [T. Huddleston]
CNC	Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa [M. Sharkey]
MNHN	Museum National d'Histoire Naturelle, Paris [J. Casevitz-Weulersse]
RNHL	Rijksmuseum van Natuurlijke Historie, Leiden [C. van Achterberg]
RMSEL	Rocky Mountain Systematic Entomology Laboratory, Laramie
TAMU	Texas A&M University, College Station [R. Wharton]
TMB	Természettudományi Múzeum Állatára, Budapest [J. Papp]
USNM	United States National Museum of Natural History, Washington, D.C. [P. Marsh]
ZIL	Zoological Institute, Academy of Sciences, Leningrad, USSR [S. Belokobylskij]
ZMH	Zoologisches Museum, Humboldt-Universität zu Berlin [F. Koch]
ZML	Zoological Museum, Lund [R. Danielsson]

I am grateful to the above mentioned curators for making specimens available, by loan or exchange.

This research was supported in part by a research grant from the American Philosophical Society. Additional funding was provided by the Department of Plant, Soil, and Insect Sciences, University of Wyoming, for which I am grateful to Dr. James Wangberg for his unswerving support.

Figure 1, the habitus of *Neoneurus mantis,* was done by Ms. Katherine Brown-Wing of the Museum of Comparative Zoology, Harvard University and is reproduced here by permission of the artist.

Figure 2, the forewing of *Neoneurus diabolicus,* is modified from Marsh et al. (1987), and was reproduced with the permission of the senior author.

Specimens of the ant *Formica podzolica* Francoeur were identified by Mr. Stefan Cover of the Museum of Comparative Zoology, Harvard University, James P. O'Connor, of the National Museum of Ireland, kindly provided a photocopy of Haliday's 1838 essay. Prof. Lew Bagby, of the University of Wyoming, provided critical Russian translations.

Literature Cited

Achterberg, C. van. 1990. Illustrated key to the subfamilies of Holarctic Braconidae (Hymenoptera:

Ichneumonoidea). Zoologische Mededelingen Leiden 64(1): 1–20.

Ashmead, W. H. 1900. Classification of the ichneumon-flies, or the superfamily Ichneumonoidea. Proceeding of the United States National Museum 23: 1–220.

Belokobylskij, S. A. 1986. Five new species of braconids (Hymenoptera: Braconidae) from the Asiatic part of the USSR, pp. 28–40. *In* Ler, P. A., S. A. Belokobylskij, and N. A. Storozheva, eds., Hymenoptera of Eastern Siberia and the Far East. Collected Works. Academy of Sciences USSR, Far East Science Centre, Vladivostok. 1986:1–152. [in Russian]

Bengtsson, S. 1918. Die Gattungen *Neoneurus* Haliday und *Elasmosoma* Ruthe, Monographische dargestelt. Acta Universitatis Lundensis 14(32): 3–28.

Čapek, M. 1970. A new classification of the Braconidae (Hymenoptera) based on the cephalic structures of the final instar larva and biological evidence. The Canadian Entomologist 102: 846–875.

Donisthorpe, H. St. J. K. 1909a. Myrmecophilous notes for 1909. Entomologist's Record London 21: 287–291.

———. 1909b. Minutes of the Entomological Society of London. The Entomologist 42: 286–288.

———. 1927. The Guests of British Ants, Their Habits and Life Histories. G. Routledge & Sons Ltd., London. 244 pp.

Fahringer, J. 1935 (1936). *Opuscula braconologica.* Vienna, 4 Lief. (1–3), 256 pp, 1 pl.

Foerster, A. 1862. Synopsis der Familien und Gattungen der Braconiden. Verhandlungen Naturhistorischer Verein der Preussischen Rheinlande 19: 224–288.

Giraud, J. 1871. Miscellanées Hyménoptérologiques. Annales Societe Entomologique de France 5: 299–301.

Haliday, A. H. 1838. Essay on the classification of parasitic Hymenoptera. Entomologist's Monthly Magazine London 5: 207–248.

Huddleston, T. 1976. A revision of *Elasmosoma* Ruthe (Hymenoptera: Braconidae) with two new species from Mongolia. Annales Historico-Naturales Musei Nationalis Hungarici 68: 215–225.

Marsh, P. M. 1979. Family Braconidae, pp. 144–295. *In* Krombein, K. V., P. D. Hurd, D. R. Smith, and B. D. Burks, eds., Catalog of Hymenoptera in America North of Mexico. Smithsonian Institution Press, Washington, D.C.

Marsh, P. M., S. R. Shaw, and R. Wharton. 1987. An identification manual for the North American genera of the family Braconidae (Hymenoptera). Memoirs of the Entomological Society of Washington 13: 1–98.

Marshall, T. A. 1897. Les Braconides (Supplement). *In* E. Andre, ed., Species des Hymenopteres d'Europe et d'Algerie. Vol. 5. Dubosclard, Paris. 369 pp.

Morley, C. 1909. Notes on the Braconidae. X. On the Pachylommatinae, with descriptions of new species. Entomologist's Monthly Magazine London 45: 209–214.

———. 1914a. Synonymy of *Euphorus bistigmaticus* Marshall with *Neoneurus halidaii* Marshall. Entomologist's Monthly Magazine London 50(25): 16.

———. 1914b. Synonymy of *Neoneurus halidaii* Marshall with *Elasmosoma berolinense* Ruthe. Entomologist's Monthly Magazine London 50(25): 93.

Muesebeck, C. F. W. 1922. A revision of the North American ichneumon-flies belonging to the subfamilies Neoneurinae and Microgasterinae. Proceedings of the United States National Museum 61: 1–76.

———. 1931. Descriptions of a new genus and eight new species of ichneumon-flies with taxonomic notes. Proceedings of the United States National Museum 79: 1–16.

Nixon, G. E. J. 1934. On the synonymy of *Elasmosoma berolinense* Ruthe, as known in England. Entomologist's Monthly Magazine London 70: 182–183.

Shenefelt, R. D. 1969. *Hymenopterorum Catalogus* Pars 4 (nov. ed.) Braconidae 1, Hybrizoninae, Euphorinae, Cosmophorinae, Neoneurinae, Macrocentrinae: 1–176. Junk, 's-Gravenhage.

Thomson, C. G. 1895. Bidrag till Braconidernas kannedom. Opuscula Entomologica. 20: 2142–2339.

Tobias, V. I. 1966. Generic groupings and evolution of parasitic Hymenoptera of the subfamily Euphorinae (Hymenoptera, Braconidae). II. Entomologiceskoe Obozrenie 45: 612–633. [Translation in Entomological Review Washington 45: 348–358.]

———. 1977. A new genus and some new species of braconids (Hymenoptera, Braconidae) from Mongolia. Nasekomye Mongol orny shav'zh [Insects of Mogolia] 5: 470–480. [in Russian]

Tobias, V. I., S. A. Belokobylskij, and A. G. Kotenko. 1986. Guide to the Insects of the European Part of the USSR. Hymenoptera. Nauka Publishing, Leningrad. Opredeliteli Faune SSSR 3(4) 1986:1–500. [in Russian]

Tobias, V. I. and E. Yu. Yuldashev. 1979. Three new remarkable species and two new genera of braconids (Hymenoptera: Braconidae: Neoneurini), pp. 95–102. *In* New Species of Insects from the Asiatic Part of the USSR. Proceedings of the Zoological Institute, Academy of Sciences, USSR, Volume 88. Nauka Publishing, Leningrad. [in Russian]